

The listing of Claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently amended) A method for treating a high dielectric layer of a semiconductor device, comprising:

nitriding a high dielectric layer on a silicon substrate, wherein said high dielectric layer comprises a multi-layered nano laminate comprising formed by forming a Group 3 metal oxide layer and a layer selected from the group consisting of a hafnium oxide layer and or a zirconium oxide layer on the substrate using atomic layer deposition and then forming a Group 3 metal oxide layer thereon using atomic layer deposition; and

post treating the high dielectric layer and silicon substrate.

2. (Original) The method of claim 1, wherein nitriding a high dielectric layer comprises nitriding said high dielectric layer using a nitriding process selected from the group consisting of a nitrogen plasma treatment process, a thermal treatment process in a nitrogen atmosphere, and a thermal treatment process comprising thermally treating the high dielectric layer after forming a nitrogen layer on the high dielectric layer.

3. (Original) The method of claim 1, wherein post treating the high dielectric layer and silicon substrate comprises post treating using a process selected from the group consisting of an oxidation process and an annealing process.

Claims 4-5 (Canceled).

6. (Original) The method of claim 5, wherein the Group 3 metal oxide layer is selected from the group consisting of aluminum oxide and yttrium oxide.

7. (Original) The method of claim 5, further comprising depositing an additional layer over the silicon substrate, the additional layer selected from the group consisting of a hafnium silicate layer, a zirconium silicate layer, and an aluminum silicate layer.

8. (Currently amended) A method for treating a high dielectric layer of a semiconductor device, comprising:

nitriding a silicon substrate and a high dielectric layer on said silicon substrate, said high dielectric layer comprising a multi-layered nano laminate ~~at least one layer selected from the group consisting of~~ formed by forming a hafnium oxide layer[[],] or a zirconium oxide layer[[],] on the substrate using atomic layer deposition and then forming a Group 3 metal oxide layer thereon using atomic layer deposition; and then annealing the silicon substrate and high dielectric layer.

9. (Original) The method of claim 8, wherein the Group 3 metal oxide layer is selected from the group consisting of an aluminum oxide layer and a yttrium oxide layer.

10. (Currently amended) The method of claim 8, wherein the nano laminate is formed by depositing an additional high dielectric layer further comprises ~~at least one~~ layer selected from the group consisting of a hafnium silicate layer, a zirconium silicate layer, and an aluminum silicate layer.

11. (Original) The method of claim 8, wherein said nitriding is performed using a nitriding process selected from the group consisting of a nitrogen plasma treatment process, a thermal treatment in a nitrogen atmosphere process, and a process comprising forming a nitrogen layer over the high dielectric layer and thermally treating the formed nitrogen layer.

12. (Original) The method of claim 8, wherein said annealing the silicon substrate and high dielectric layer comprises annealing the silicon substrate and high dielectric layer in an atmosphere selected from the group consisting of an inert gas

atmosphere, a heavy hydrogen atmosphere, a hydrogen atmosphere, a mixed nitrogen and hydrogen gas atmosphere, and a vacuum atmosphere.

13. (Original) The method of claim 8, wherein said annealing the silicon substrate and high dielectric layer comprises annealing the silicon substrate and high dielectric layer at a temperature at or between about 750 °C and 1100 °C.

14. (Currently amended) A method for treating a high dielectric layer of a semiconductor device, comprising:

nitriding a silicon substrate and a high dielectric layer on said silicon substrate, said high dielectric layer comprising a multi-layered nano laminate formed by forming at least one layer selected from the group consisting of a hafnium oxide layer[[,]] or a zirconium oxide layer on the substrate using atomic layer deposition, and then forming a Group 3 metal oxide layer thereon using atomic layer deposition; and
then oxidizing the silicon substrate and high dielectric layer.

15. (Original) The method of claim 14, wherein the Group 3 metal oxide layer is selected from the group consisting of an aluminum oxide layer and a yttrium oxide layer.

16. (Currently amended) The method of claim 14, wherein the multi-layered nano laminate is formed by forming an additional layer ~~high dielectric layer further comprises at least one layer selected from the group consisting of~~ comprising a hafnium silicate layer, a zirconium silicate layer, ~~[[and]]~~ or an aluminum silicate layer.

17. (Original) The method of claim 14, wherein said nitriding is performed using a nitriding process selected from the group consisting of a nitrogen plasma treatment process, a thermal treatment in a nitrogen atmosphere process, and a process comprising forming a nitrogen layer over the high dielectric layer and thermally treating the formed nitrogen layer.

18. (Original) The method of claim 14, wherein said oxidizing the silicon substrate and high dielectric layer comprises wet oxidizing the silicon substrate and high dielectric layer.

19. (Original) The method of claim 14, wherein said oxidizing the silicon substrate and high dielectric layer comprises dry oxidizing the silicon substrate and high dielectric layer.

20. (Original) The method of claim 14, wherein said oxidizing the silicon substrate and high dielectric layer comprises oxidizing the silicon substrate and high dielectric layer with an oxidizing agent selected from the group consisting of ozone, radical oxygen, and oxygen plasma.

21. (Currently amended) A method for treating a high dielectric layer of a semiconductor device, comprising:

nitriding a silicon substrate and a high dielectric layer on said silicon substrate, said high dielectric layer comprising a multi-layered nano laminate formed by forming at least one layer selected from the group consisting of a hafnium oxide layer[[,]] or a zirconium oxide layer on the substrate using atomic layer deposition, and then forming a Group 3 metal oxide layer thereon using atomic layer deposition; and then
oxidizing the silicon substrate and high dielectric layer; and
annealing the nitrided and oxidized silicon substrate and high dielectric layer.

22. (Original) The method of claim 21, wherein the Group 3 metal oxide layer is selected from the group consisting of an aluminum oxide layer and a yttrium oxide layer.

23. (Currently amended) The method of claim 21, wherein the multi-layered nano laminate is formed by depositing additional layer comprising high dielectric layer further comprises at least one layer selected from the group consisting of a hafnium silicate layer, a zirconium silicate layer, and or an aluminum silicate layer.

24. (Original) The method of claim 21, wherein said nitriding is performed using a nitriding process selected from the group consisting of a nitrogen plasma treatment process, a thermal treatment in a nitrogen atmosphere process, and a process comprising forming a nitrogen layer over the high dielectric layer and thermally treating the formed nitrogen layer.

25. (Original) The method of claim 21, wherein said oxidizing the silicon substrate and high dielectric layer comprises wet oxidizing the silicon substrate and high dielectric layer.

26. (Original) The method of claim 21, wherein said oxidizing the silicon substrate and high dielectric layer comprises dry oxidizing the silicon substrate and high dielectric layer.

27. (Original) The method of claim 21, wherein said oxidizing the silicon substrate and high dielectric layer comprises oxidizing the silicon substrate and high dielectric layer with an oxidizing agent selected from the group consisting of ozone, radical oxygen, and oxygen plasma.

28. (Original) The method of claim 21, wherein said annealing the nitrated and oxidized silicon substrate and high dielectric layer comprises annealing the nitrated and oxidized silicon substrate and high dielectric layer in an atmosphere selected from the group consisting of an inert gas atmosphere, a heavy hydrogen atmosphere, a hydrogen atmosphere, a mixed nitrogen and hydrogen gas atmosphere, and a vacuum atmosphere.

29. (Original) The method of claim 21, wherein said annealing the nitrated and oxidized silicon substrate and high dielectric layer comprises annealing the nitrated and oxidized silicon substrate and high dielectric layer at a temperature at or between about 750 °C and 1100 °C.

30. (Original) The method of claim 21, wherein said oxidizing the silicon substrate and high dielectric layer comprises oxidizing the silicon substrate and high dielectric layer at or between a temperature of about 700 °C to about 900 °C.

31. (Currently amended) A method for treating a multi-layered nano laminate high dielectric layer of an integrated circuit device, comprising nitriding to provide a nitride profile concentration in the high dielectric layer that is greater adjacent to the a polysilicon/high dielectric layer interface than adjacent to a silicon/high dielectric layer interface, wherein the multi-layered nano laminate is formed by forming a hafnium oxide layer or a zirconium oxide layer on the substrate using atomic layer deposition, and then forming a Group 3 metal oxide layer thereon using atomic layer deposition.